BIOLOGICAL EVALUATION R2-02-01
November 2001

EVALUATION OF WESTERN BALSAM BARK BEETLE FLIGHT PERIODICITY ON THE BIGHORN NATIONAL FOREST, WYOMING

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ABSTRACT

This evaluation reports the flight periodicity of western balsam bark beetle (*Dryocoetes confusus* Swaine) in the Bighorn Mountains of north-central Wyoming. Traps baited with lures were used to determine the periods of flight activity over a five-year period. A consistent pattern of flight initiation and peaks in flight activity was found for western balsam bark beetle. Similar to previous studies in other geographic locations there were two main periods of flight activity. However, flight initiation and the first and larger peak of flight activity occurred later in the season (mid-July) compared with northern Utah and Idaho. The second and smaller peak of flight activity occurred in late August. In the 2000 season, males dominated trap catches during the first 2 weeks and then were female biased the rest of the year. In addition, trap catches of western balsam bark beetle were compared by lure (1999, 2000, 2001) and trap type (2000). No significant differences were detected between lure, trap, or their interaction on the number of beetles trapped during 2000; however, the most beetles were caught in the panel trap/3-component lure combination. The potential for using pheromone lures and tree baits for managing western balsam bark beetle is discussed.

INTRODUCTION

Bark beetles (Coleoptera: Scolytidae) are the most economically important family of insects of conifers in the western United States. Furthermore, bark beetles have performed a major function in the development and maintenance of coniferous stands in the Rocky Mountains (Samman and Logan 2000). Despite their important role in forest ecosystems and their economic impact, we do not have a detailed knowledge of life history traits for many beetles and variation of these traits across geographic areas. A more thorough understanding of variation in life history traits for beetles in specific areas could improve the timing of control measures.

Western balsam bark beetle can impact true firs from Canada to the southwestern United States (Molnar 1965). A current outbreak in the Bighorn National Forest in Wyoming has killed more than 70 trees per acre over a five-year period (McMillin et al. 2001). The beetle is associated with spruce-fir stands containing a high density of large fir trees on this Forest. Storm-damaged fir trees (e.g., windthrow or blowdown) also may play an important role in triggering population increase of this beetle (Stock 1991, McMillin et al. 2001).

Although the biology of the western balsam bark beetle is not well known, the need to understand its life cycle and behavior has increased in relation to the increased commercial, aesthetic and recreation value of true firs (Hansen 1996). Information from Utah, Idaho, Montana, and British Columbia suggests that it has a two-year life cycle, but may vary between one – two years depending on latitude, weather conditions and elevation (Bright 1963, Stock 1991, Hansen 1996, Gibson et al. 1997). Beetles can fly throughout the summer beginning in early June in Utah, Montana, and British Columbia. Males typically initiate attacks on the boles of susceptible host trees. Upon initiating the attack, males bore into the phloem, excavate a nuptial chamber, then attract and mate with several females. Two – seven egg galleries radiate from the central nuptial chamber. Larvae feed throughout the remaining summer and fall in the phloem and extend their mines until freezing weather. The first overwintering is therefore typically spent as dormant larvae. Development is continued in the spring and summer, and then, overwinter as adults during the second winter as adults or pupae (Stock 1991, Hansen 1996, Gibson et al. 1997).

Similar to other bark beetles, the pheromone biology of western balsam bark beetle has been studied (Stock and Borden 1983, Borden et al. 1987, Stock et al. 1990, Camacho and Borden 1995, Stock et al. 1994a,b). Commercially available pheromone tree baits (*exo*-brevicomin) can be used to monitor beetle flight activity and concentrate beetles into stands scheduled for harvest (Stock et al. 1994a,b).

This evaluation reports on five years of data collected from trapping beetles on the Bighorn National Forest. Our objective was to define the period of flight activity of western balsam bark beetle. A secondary objective was to compare a new trap type and lures with commercially available products currently being used. At the time of this study was completed, lures (aggregation pheromone plus host tree compounds) specific for monitoring western balsam bark beetle were not commercially available. Therefore, we used the tree bait for western

balsam bark beetle as a lure on monitoring traps. Lures that contain both aggregation pheromones and host component compounds may increase trap catches.

METHODS AND MATERIALS

To learn more about the flight periodicity of western balsam bark beetle, western balsam bark beetle traps were located in spruce-fir stands on the Bighorn National Forest. Phero Tech's Lindgren 12-unit funnel traps (1996, 1997, 1999, 2000, 2001) and IPM Technologies' Intercept panel traps (1999, 2000) were deployed at sites on the Bighorn National Forest. Traps were placed at each site between June 6^{th} and July 9^{th}, and were retrieved in mid- to late-September. Traps were located throughout the spruce-fir forest type adjacent to Forest Service Road 15 between Schuler Park and 2.5 miles from the west end of the FS15 and Highway 14A intersection. All trap locations were located near active western balsam bark beetle infestations. "Trap were hung as high as possible on branches, leaving the trap cup about 4 feet aboveground".

In both 1996 and 1997, one 12-unit funnel trap was placed at each of four sites. Trap cups were checked every 1 – 4 weeks in 1996 and every 2 weeks throughout the duration of study period in 1997.

Traps were placed at each of 9 sites in 1999. Three traps were used at each site to compare trap type and lure type. One trap contained Phero Tech's tree bait (*exo*-brevicomin) on a funnel trap, one contained IPM Technologies' 1-component (*exo*-brevicomin) lure on a panel trap, and the third trap contained IPM Technologies' 3-component lure (*exo*-brevicomin, myrcene, and myrtenol) on a panel trap. The traps and lures were assigned at random to a position at each site. Distance between traps at a site ranged between 50 – 75 feet. Trap cups were checked weekly throughout the duration of study period.

Traps were placed at each of 10 sites in 2000. Two trap types and two lure types were compared at each site: funnel trap with Phero Tech tree bait, panel trap with Phero Tech tree bait, funnel trap with IPM Technologies' 3 component lure, and panel trap with IPM Technologies 3 component lure. The traps and lures were assigned at random to a position at each site. Traps at a site were separated by 1 chain (66 feet). Trap cups were checked weekly throughout the duration of study period. Sex of collected beetles was determined on a subsample from each trap during the 2000 season. The first 10 beetles collected from each trap were sorted as male and female beetles using the prominent setal brush on the frons of females as the diagnostic anatomical characteristic (Borden et al. 1987). This subsampling was used to determine the sex ratio throughout the flight periods of 2000. Data were summarized and analyzed using SAS© (SAS Institute 1999).

Traps were placed at each of 15 sites in 2001. Two lure types were compared under 3 different stand conditions. The lures were a Phero Tech tree bait and IPM Technologies 3 component lure. The differing conditions were: 5 sites had the traps hung on live fir trees, 5 sites had the traps hung on dead fir trees and 5 sites had the traps hung on non-host, lodgepole pine trees. The traps and lures were assigned at random to a position at each site.

Traps at a site were separated by 1 chain (66 feet). Trap cups were checked weekly throughout the duration of the study.

RESULTS AND DISCUSSION

The peak flight activity of western balsam bark beetle probably occurred in mid July for all 5 years of the study (Figures 1 – 6). In 1996, because traps were not deployed until July 9th, we missed the beginning of the flight period (Figure 1). However, the number of beetles decreased rapidly between July 19th and July 25th. For the other 4 years the study there was a rapid increase in the number of beetles trapped between the first week and third week of July. Although the general pattern of flight activity was similar to that reported earlier for the Rocky Mountain region of the United States (Hansen 1996, Gibson et al. 1997), the peaks of flight activity in the Bighorn Mountains of Wyoming seem to occur later. Essentially, we did not trap any beetles during the months of June. Studies in Idaho had a first peak of activity in early June in 2 of 3 years studied. Beetle activity in Montana also began during June although the timing was quite variable.

There also was a slight increase in trapped beetles between 5 to 7 weeks after the first peak period of flight activity. This second period of flight activity in late August to early September is similar to that reported in previous studies (Hansen 1996, Gibson et al. 1997).

In 1999, it was apparent that the tree bait trapped more beetles per trap during the peak flight period than did the 1 or 3 component lures, but there were no differences between traps or lures for other sampling dates (Figure 4). This finding is difficult to explain; however, it may be that elution rates for the 3-component lure was below that needed to detect a response by the beetles.

In 2000, there were a total of nearly 61,000 beetles caught across all traps and sites. Fifty-four percent of these were collected on July 13th. The most beetles were collected in the panel trap/3-component lure combination and the least in the funnel trap/tree bait combination for the period of peak flight activity and the complete season (Table 1, Figure 6). However, no statistical difference was detected over the whole period of beetle collection or for the peak week because of the large variation around the means. Moreover, all trap type/lure type combinations showed the same pattern of flight activity. Previous studies have shown that myrtenol can act as a synergist with exo-brevicomin for increasing beetle catches in traps (Borden et al. 1987).

The sex ratio changed from first 2 weeks of flight activity to the rest of the 2000 season (Figure 7). Male beetles dominated initial trap catches and the rest of the season was slightly biased by females. This pattern is similar to that reported in previous studies (Hansen 1996, Gibson et al. 1997).

Table 1. Summary of western balsam bark beetle trap catches during 2000 season on the Bighorn National Forest, Wyoming.

Trap type/ lure treatment	Peak Sum	Peak Mean (±SEM)	Season Sum	Season Mean (±SEM)
Funnel/tree bait	6,735	673.5 (788.7)	13,501	113.4 (111.8)
Funnel/3 component	7,763	776.3 (484.1)	14,809	124.9 (128.0)
Panel/tree bait	8,910	891.0 (747.6)	16,306	140.0 (150.4)
Panel/3 component	9,758	975.8 (622.0)	16,350	146.7 (158.1)
Funnel	14,498	724.9 (450.9)	28,310	119.2 (64.8)
Panel	18,668	933.4 (473.7)	32,656	142.3 (72.9)
Tree bait	15,645	782.3 (531.1)	29,807	125.7 (77.0)
3 component	17,521	876.1 (386.2)	31,159	135.8 (60.6)

In 2001, there were a total of nearly 14,532 beetles caught across all traps and sites. Thirty percent of these were collected on July 11th (Figure 8). Of the 14,532 beetles collected, 7,356 (51%) were caught in traps with tree bait and 7,176 (49%) were caught using 3 component lure (Figure 9). The totals during the peak flight (July 11) date were also almost 50-50. Of the three different location placements, 7,704 (53%) were caught in traps placed on live fir trees. 3,761 (26%) were caught in traps located on dead fir and 3,065 (21%) were caught in traps located on non-host trees. This result is expected, as it can be assumed that there are some host volatiles that may add to the attractiveness of the pheromone lures, leading to the highest catches being in the traps hung in live fir. The most beetles were collected in the tree bait/live fir combination and the least in the pine/tree bait combination for the period of peak flight activity and the complete season (Figure 10). All of the lure type/location combinations showed the same pattern of flight activity.

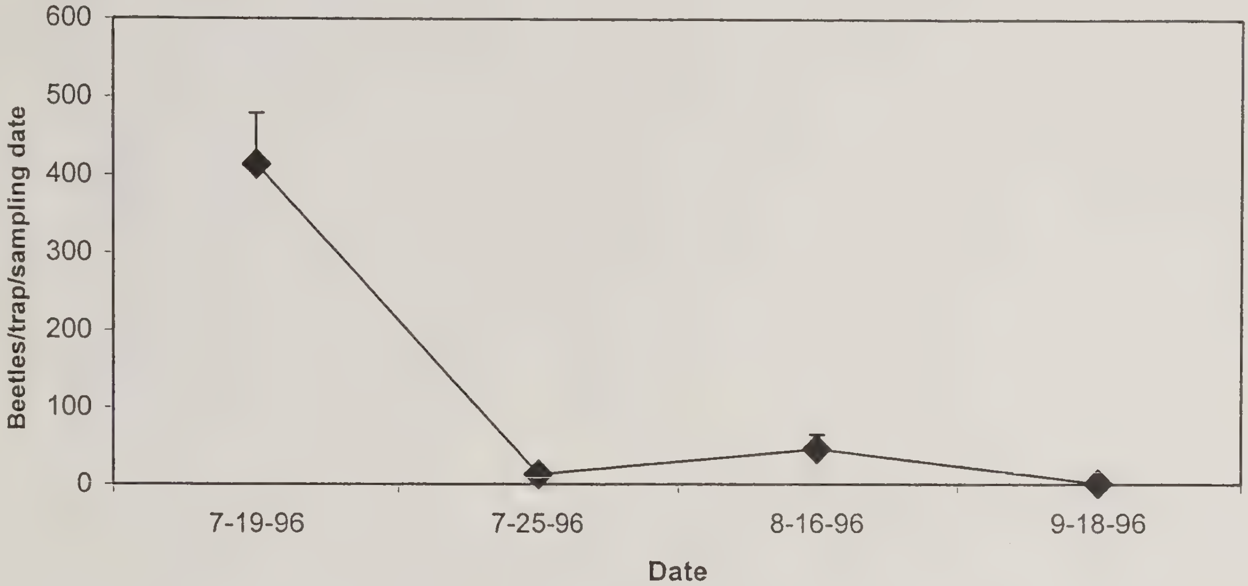

Figure 1. Trap counts (mean + 95%CI) of western balsam bark beetle during 1996 on the Bighorn National Forest.

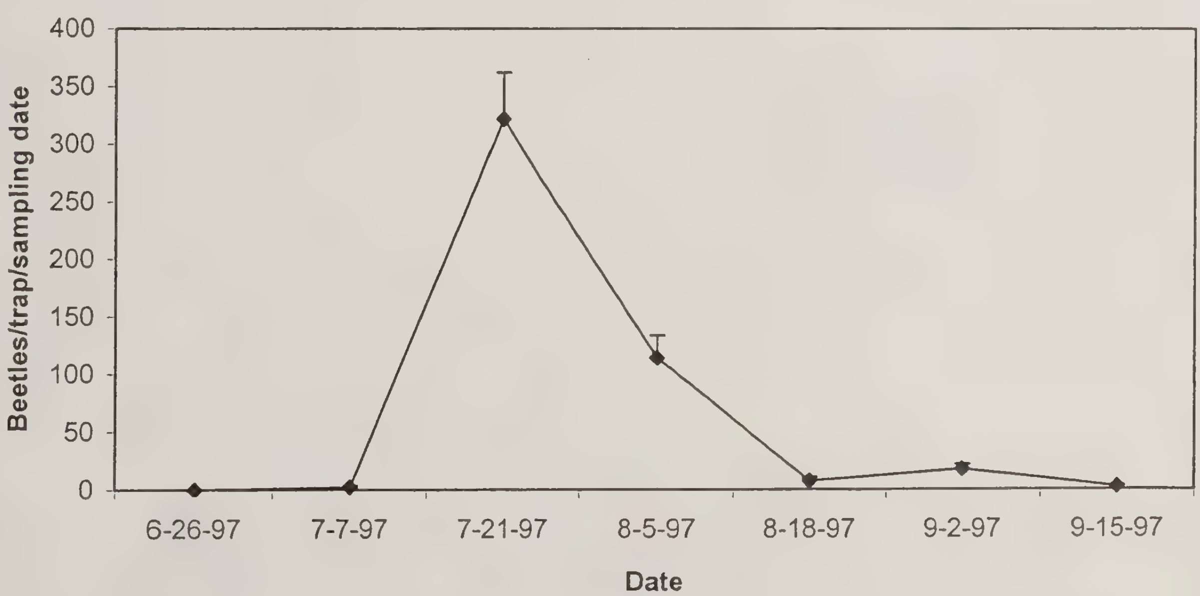

Figure 2. Trap counts (mean + 95%I) of western balsam bark beetle during 1997 on the Bighorn National Forest.

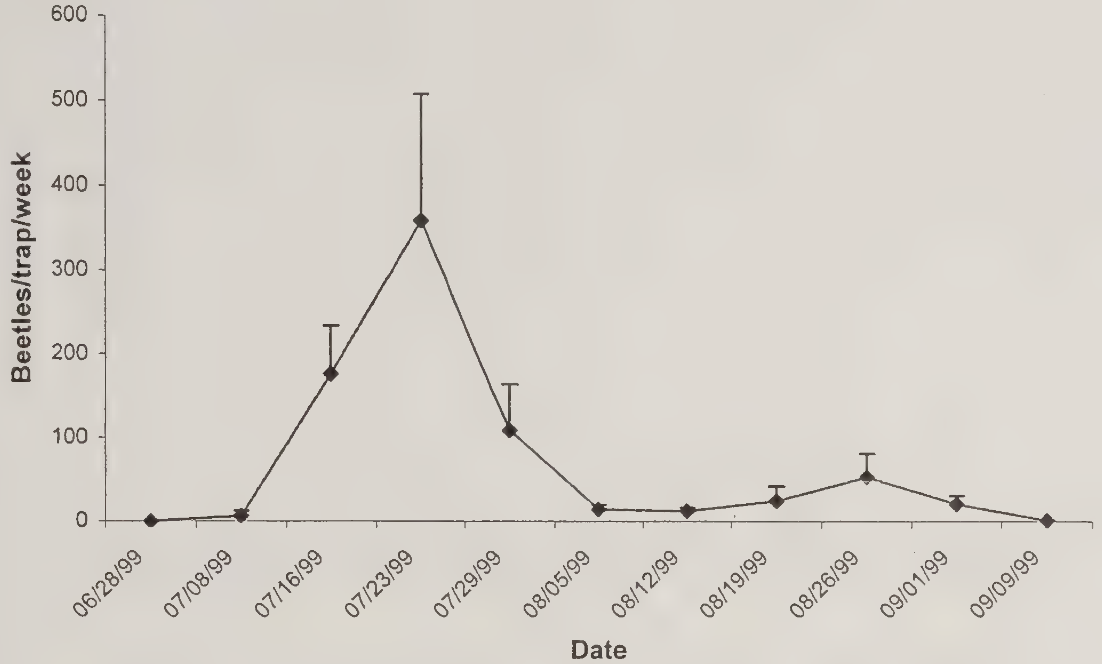

Figure 3. Trap counts (mean +95% CI) of western balsam bark beetle during 1999 on the Bighorn National Forest.

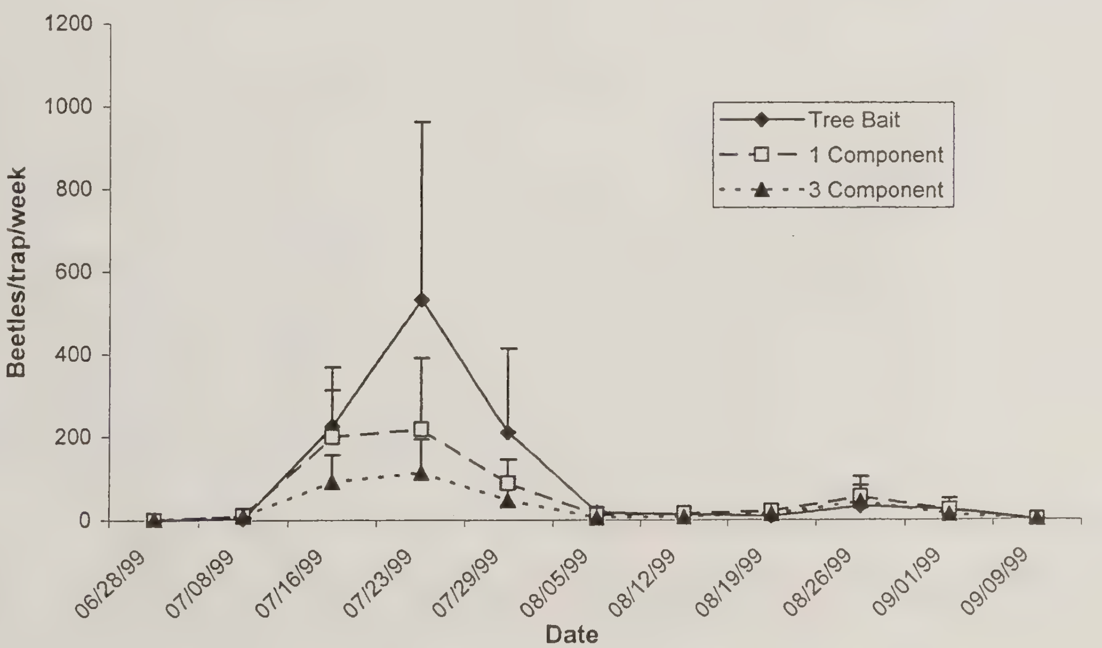

Figure 4. Trap counts (mean + 95% CI) of western balsam bark beetle during 1999 on the Bighorn National Forest.

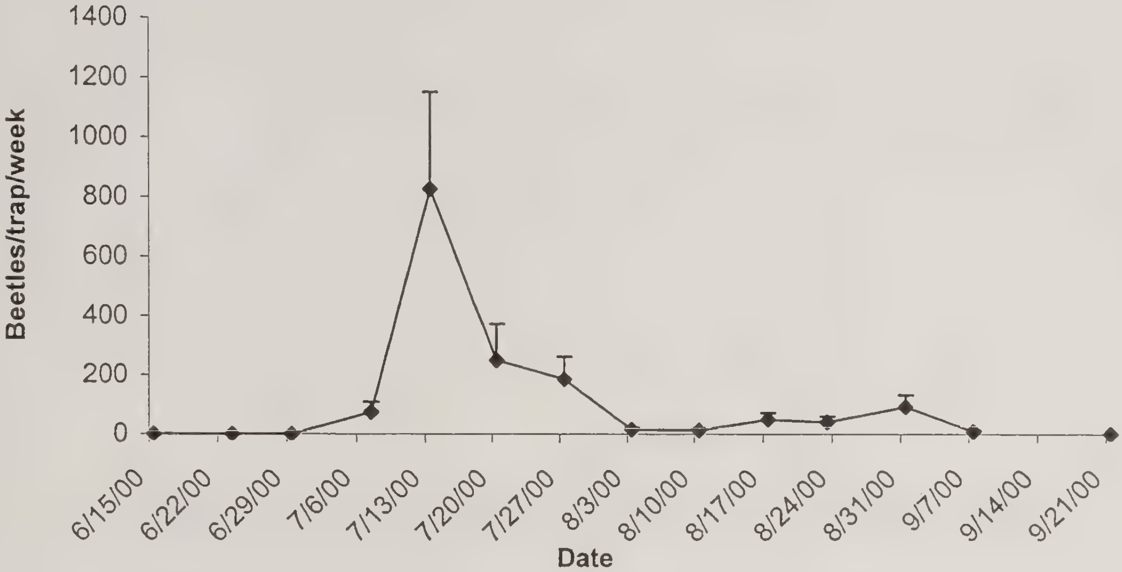

Figure 5. Trap counts (mean + 95%CI) of western balsam bark beetle during 2000 on the Bighorn National Forest.

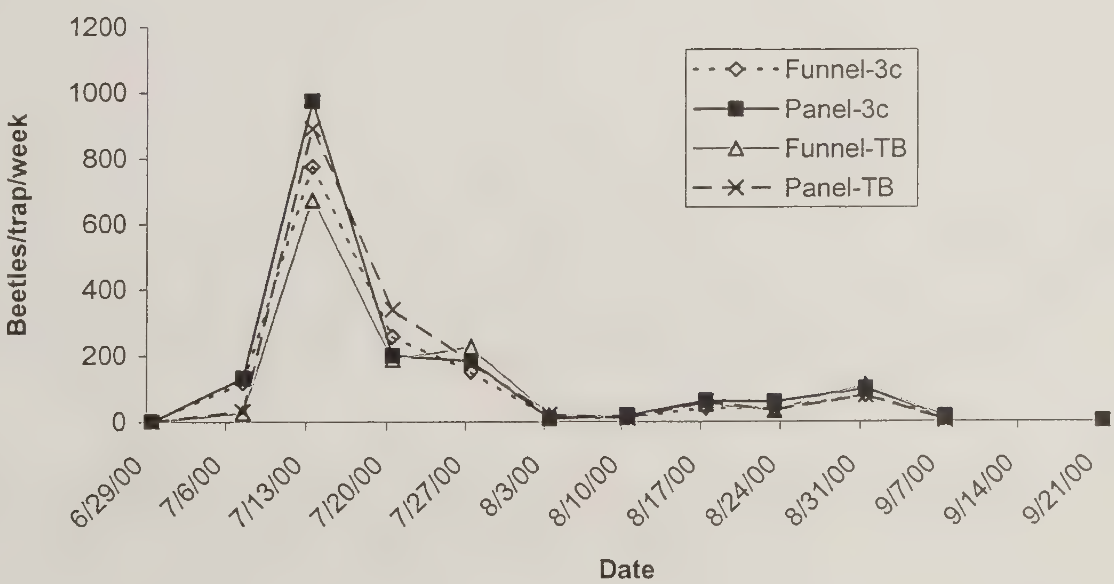

Figure 6. Trap counts of western balsam bark beetle by trap and lure type (3c = 3 component, TB = tree bait) during 2000 on the Bighorn National Forest.

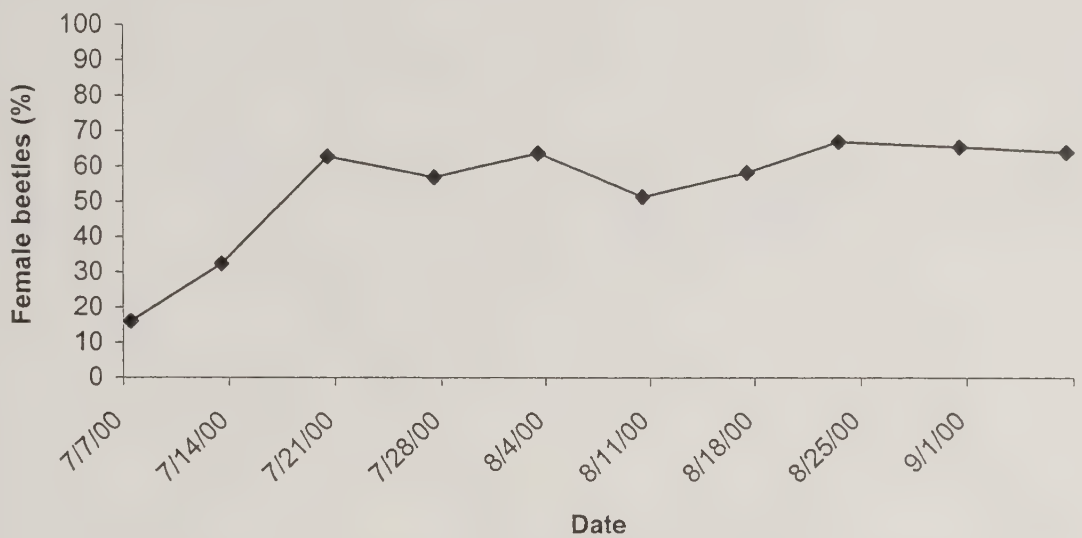

Figure 7. Percentage of female beetles by collection date during 2000 on the Bighorn National Forest.

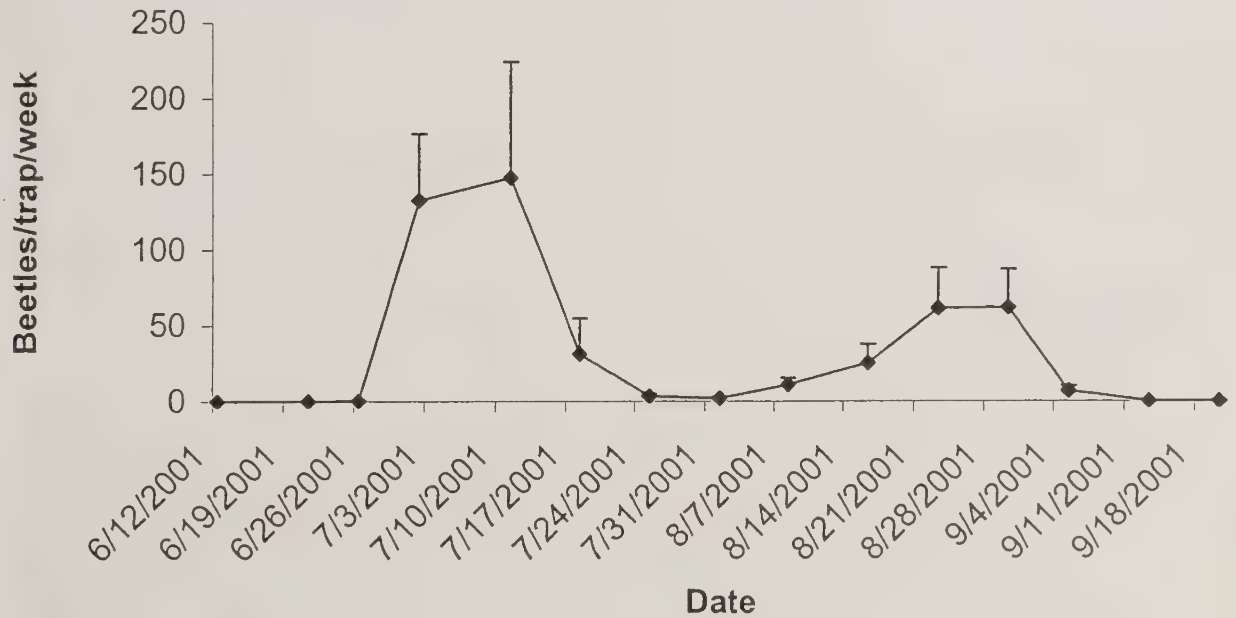

Figure 8. Trap counts (mean + SEM) of western balsam bark beetle during 2001 on the Bighorn National Forest.

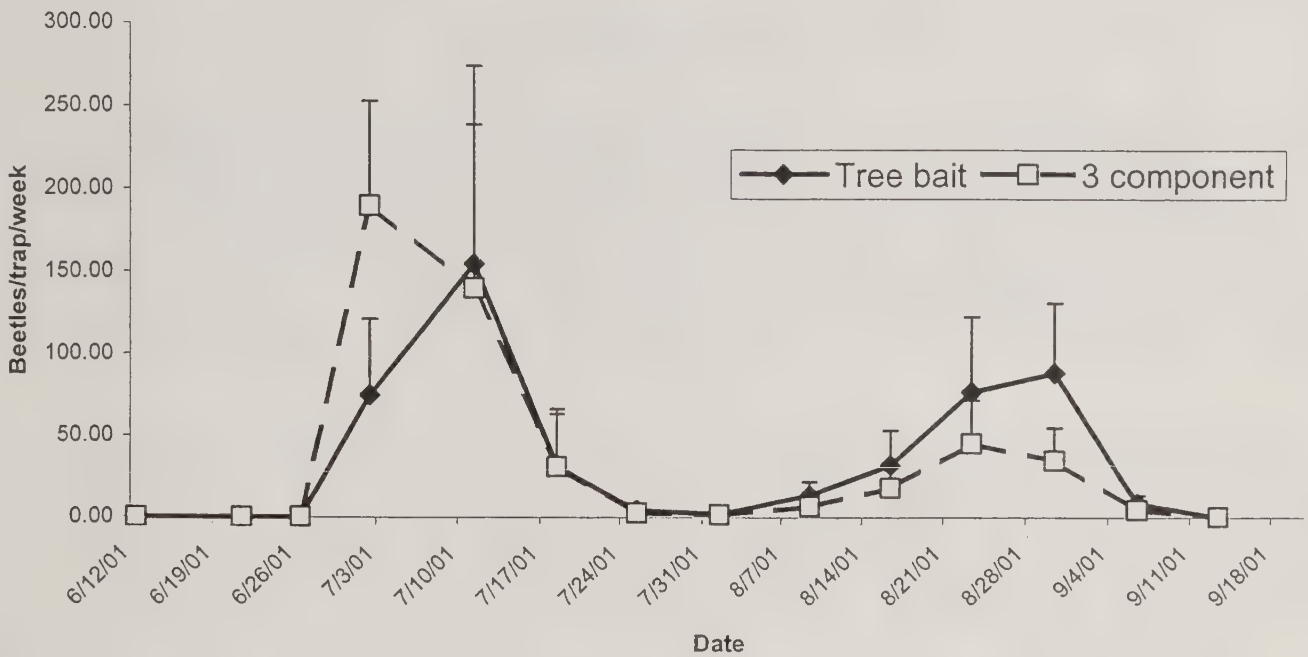

Figure 9. Comparison of lure types for western balsam bark beetle during 2001 on the Bighorn National Forest.

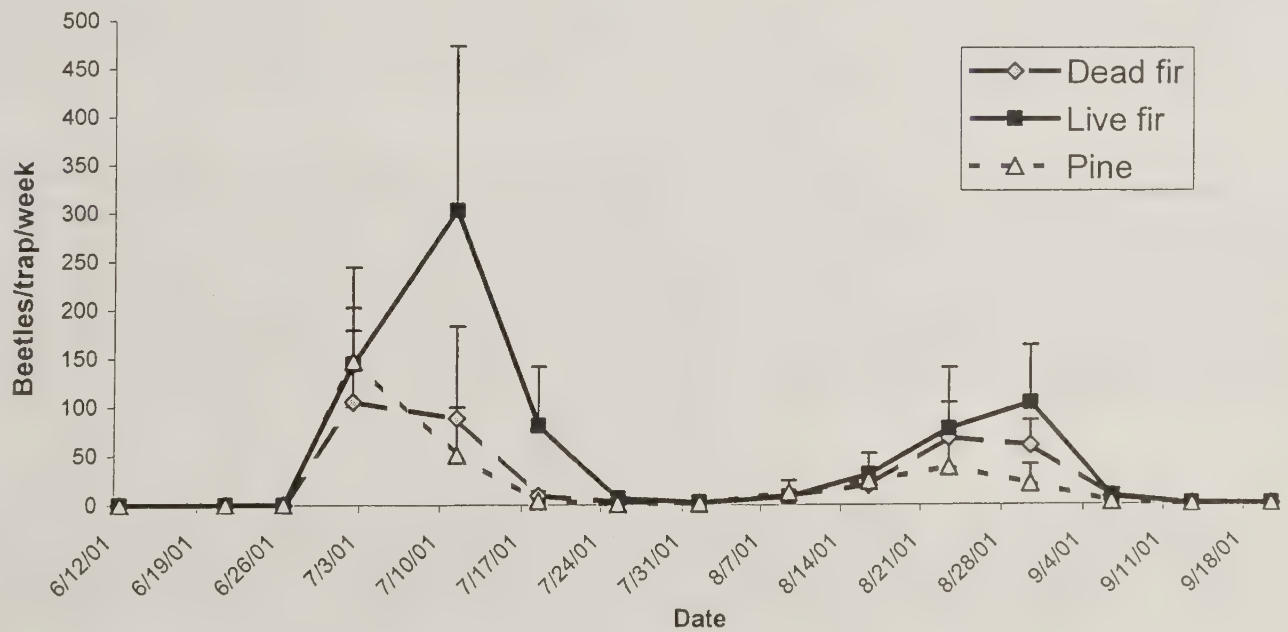

Figure 10. Comparison of trap locations on western balsam bark beetle catches during 2001 on the Bighorn National Forest.

MANAGEMENT IMPLICATIONS

We found a relatively consistent pattern of western balsam bark beetle activity over the five years of the study. Flight initiation begins in early July and quickly peaks in mid-July. Therefore, if management activities are implemented to remove infested trees, they should occur between early fall and the middle of June. If aggregation pheromones are used to manipulate the behavior of flying beetles (discussed below), pheromone lures or baits should be in place before July 1st. Based on our 2000 and 2001 data, any of the trap types and lure combinations would work for monitoring flight activity.

Forty traps caught more than 60,000 beetles during the 2000 season. This suggests that mass trapping could be used to reduce local populations of beetles. Our 2001 data indicate that traps put in stands of live hosts collect the most beetles, regardless of lure used. Placing traps in non-host stands may be less effective at collecting beetles, but it also would reduce the possibility of spillover attacks. This loss of effectiveness for gain in less spillover needs to be considered based on the desired future conditions in the stand. Mass trapping is a recommended treatment for *Ips* species and perhaps *Dendroctonus* beetles as well (Borden 1995, Shea and Neustein 1995). Further testing is needed to see if a certain combination of trap and lure would work best for mass trapping. Mass trapping would probably work the best in combination with sanitation treatments and on relatively small and local populations.

In addition to the use of traps with lures, attraction pheromones can be used in a trap tree approach (Stock et al. 1994a, Phero Tech Technical Bulletin). In this approach, standing uninfested trees are baited near infestation spots. This strategy has been shown to contain and concentrate beetles that can then be removed through sanitation treatments. Trees can be baited within or near an active spot of infestation, or on a grid pattern to reduce beetle populations over a larger area (Phero Tech Technical Bulletin). Baited trees must be harvested and processed to kill beetles as soon as possible following attack.

A third approach for manipulating beetles via pheromones involves using anti-aggregation pheromones (Borden 1995). *Endo*-brevicomin has been identified as inhibiting the response of western balsam bark beetle to *exo*-brevicomin (Stock et al. 1990). Therefore, there is the potential to use *endo*-brevicomin to prevent western balsam bark beetle from attacking trees in high value areas such as developed recreation sites. Again, the potential use of anti-aggregation pheromones should be used as only one component of a management program.

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